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Clarke

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[54] **PNEUMATIC CYLINDER WITH POSITIONING, BRAKING, AND FEED RATE CONTROL**

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[51] **Int. Cl.**[5] **F15B 7/00**

[52] **U.S. Cl.** **60/583**; 60/591; 60/593; 92/9; 92/12; 92/13.1; 92/13.6; 92/65; 92/75

[58] **Field of Search** ..... 92/8, 9, 10, 11, 13, 92/13.1, 65, 85 B, 13.6, 75; 60/591, 593, 583

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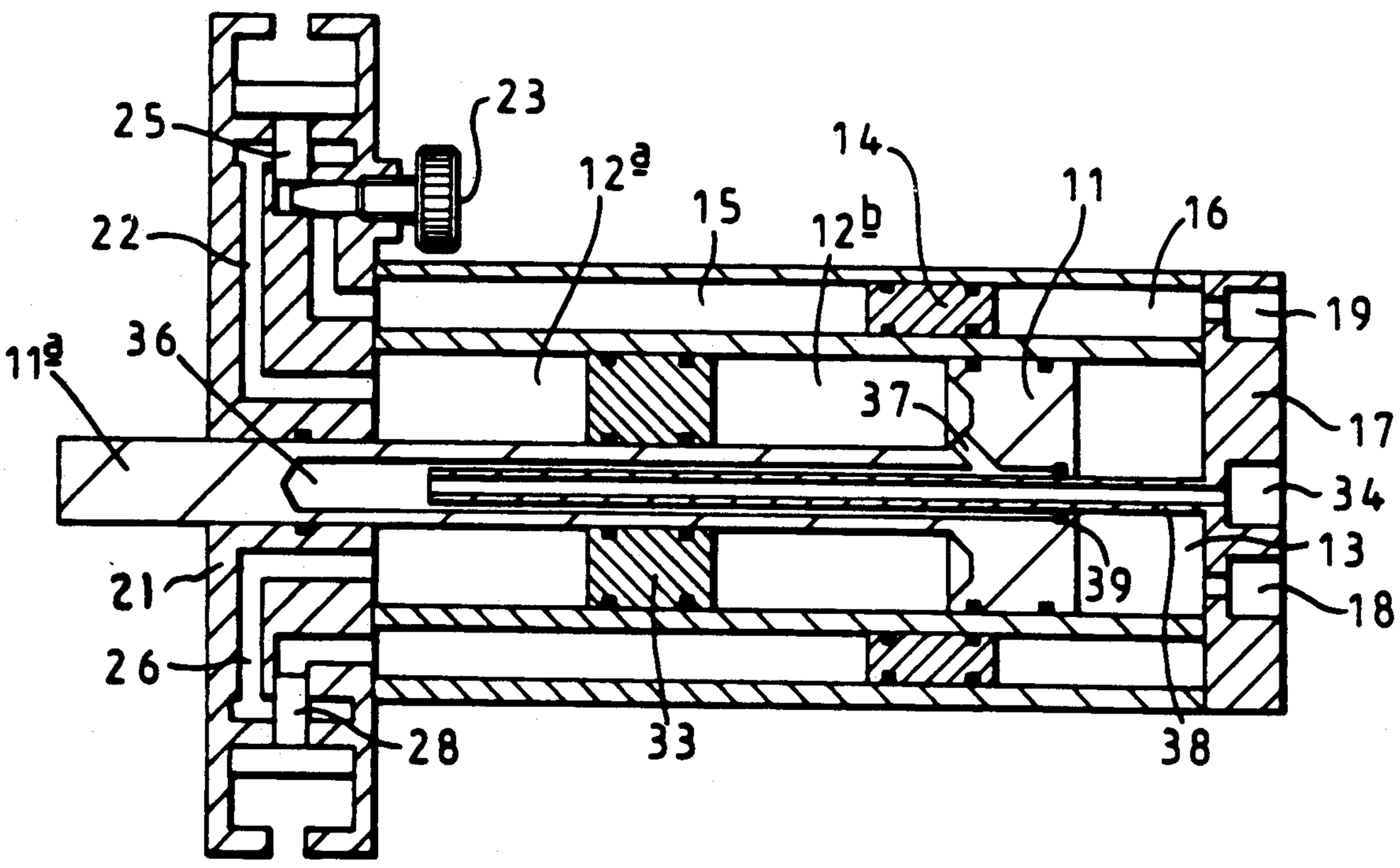
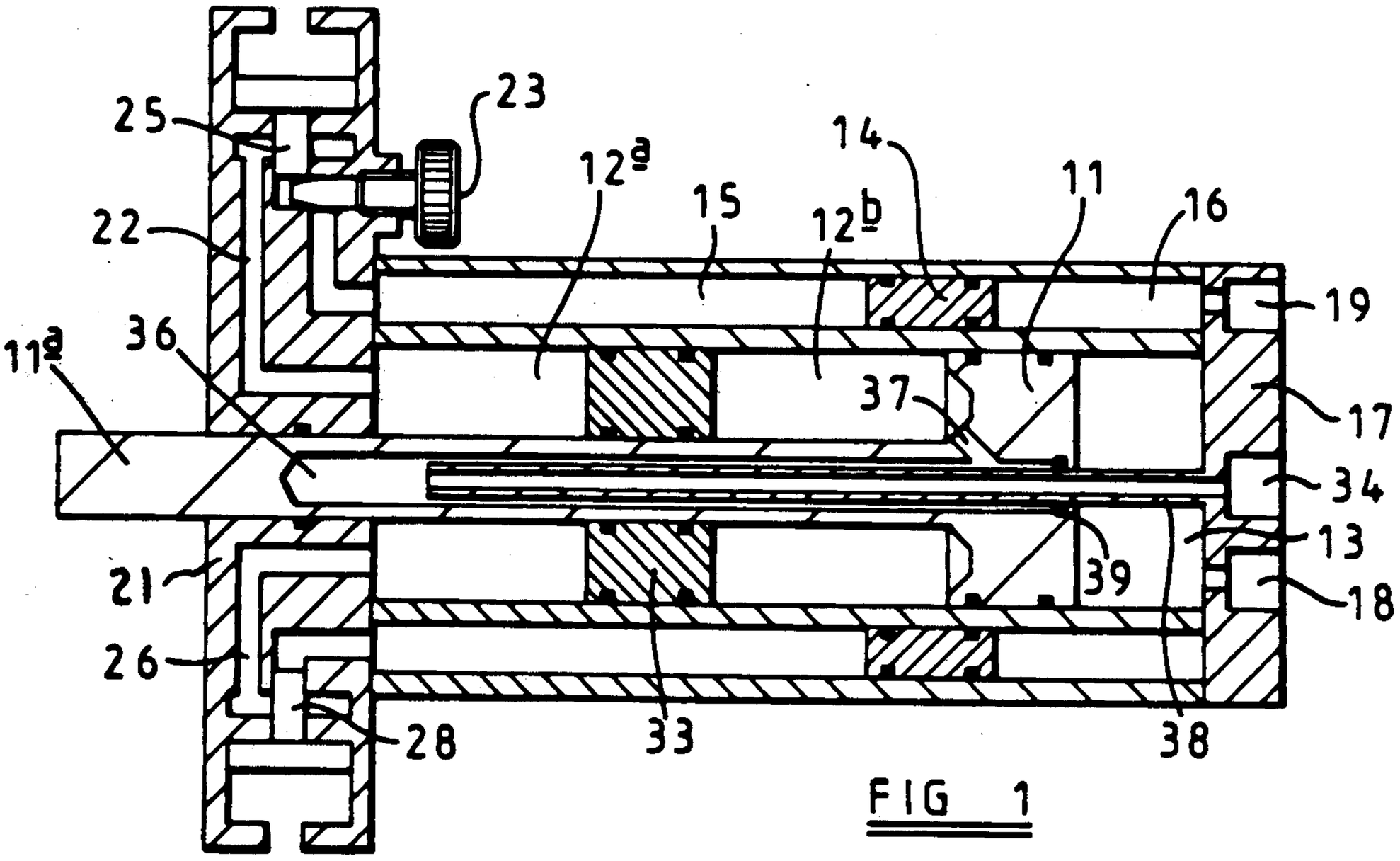
[57] **ABSTRACT**

A pneumatic piston/cylinder unit comprises primary and secondary pistons operable in first and second cylinder zones respectively. Each of the primary and secondary pistons divide its respective cylinder zone into two chambers, one of the chambers of the first cylinder zone being connected to one of the chambers of the second cylinder zone via a passageway which includes at least one control for the flow of hydraulic fluid therethrough. A tertiary piston is provided in the one chamber of the first cylinder zone and divides that chamber into two parts, one of which is between the primary and tertiary pistons. In use the passageway, the one chamber of the second cylinder zone and the other part of the one chamber of the first cylinder zone are filled with hydraulic fluid. Application of pneumatic pressure to the other chamber of the first cylinder zone causes the primary piston to be displaced until it abuts the tertiary piston whereupon movement of the primary piston may be arrested or controlled.

9 Claims, 2 Drawing Sheets




25
23
22
12a
15
14
12b
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36
11a
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18
26
28
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38

FIG 1

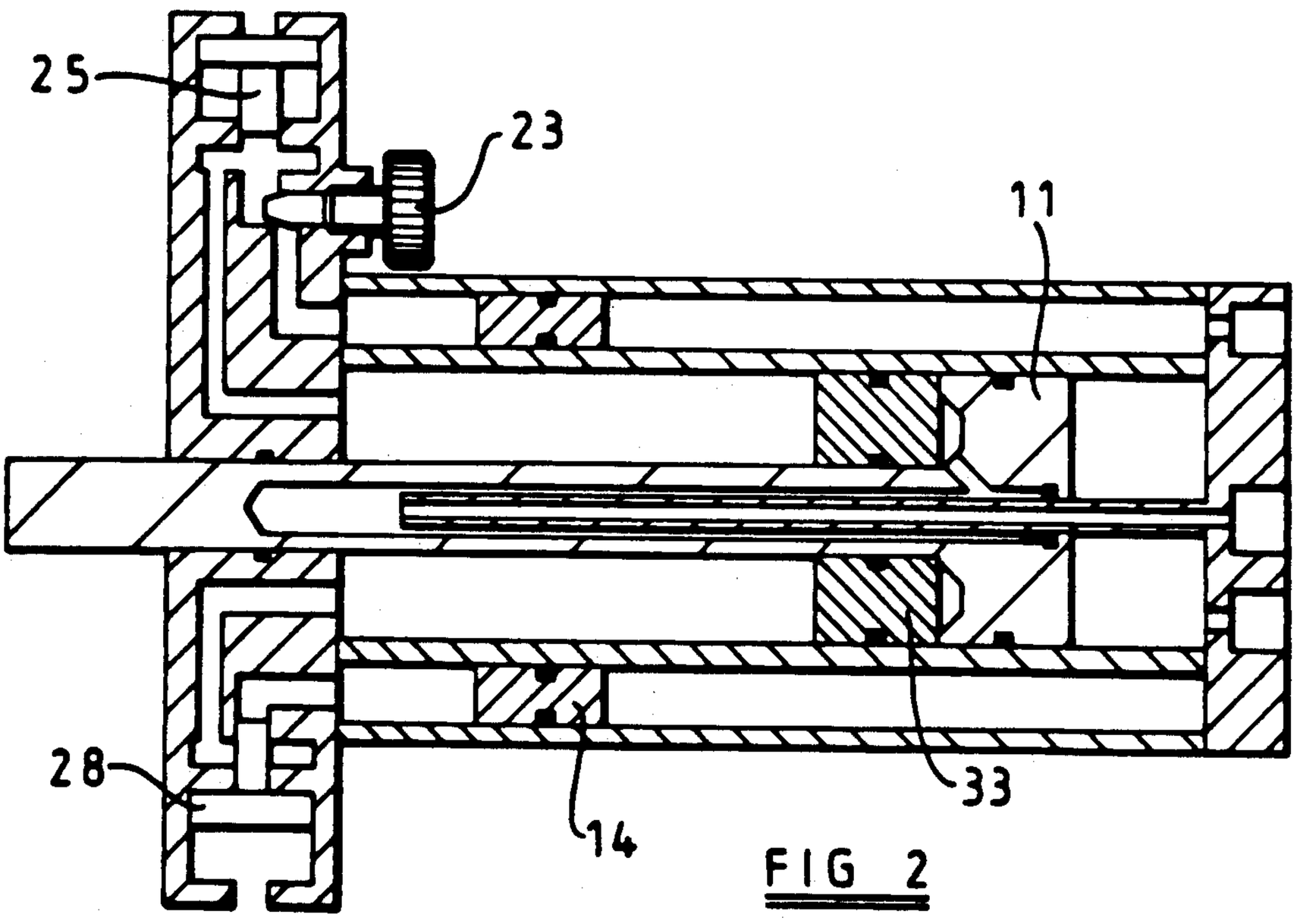
25
23
11
28
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FIG 2

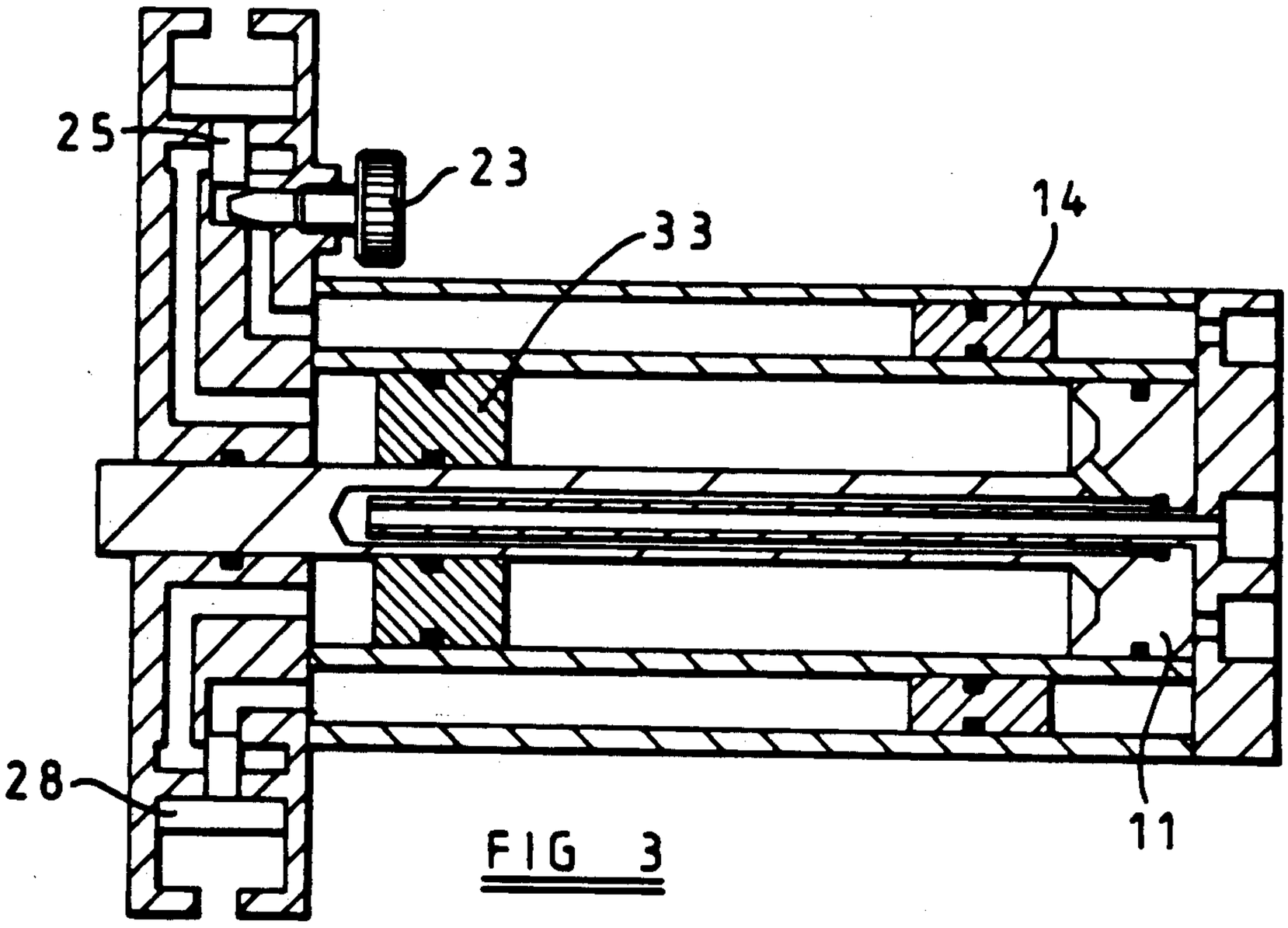

FIG 3

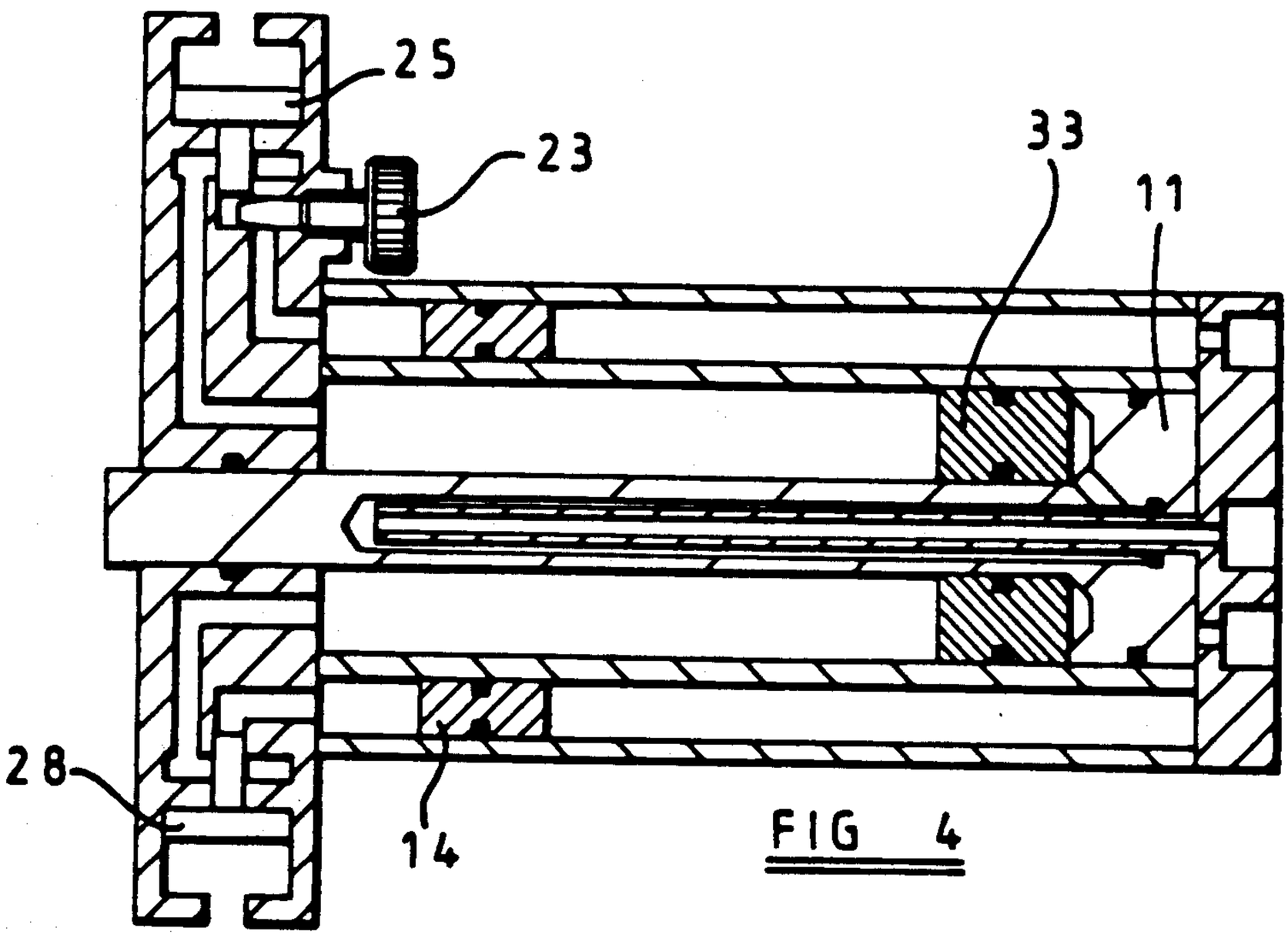

FIG 4

PNEUMATIC CYLINDER WITH POSITIONING, BRAKING, AND FEED RATE CONTROL

INTRODUCTION

This invention relates to pneumatic cylinders.

Pneumatic cylinders have a wide range of uses in automation and other control functions. It is known to provide a pneumatic cylinder with positioning capabilities, or with accurate braking, or with feed rate control. However, none of the known cylinders has all of these facilities.

SUMMARY OF THE INVENTION

Accordingly, the present invention seeks to provide a pneumatic piston/cylinder unit which is more versatile than those which are already known.

According to the present invention, there is provided a pneumatic piston/cylinder unit comprising primary and secondary pistons operable in first and second cylinder zones respectively, and each dividing its respective cylinder zone into two chambers, one of the chambers of the first cylinder zone being connected to one of the chambers of the second cylinder zone by a passageway which includes means for controlling the flow of hydraulic fluid therethrough, and a tertiary piston in said one chamber of the first cylinder zone and dividing said one chamber into two parts, one of which is between the primary and tertiary pistons, the arrangement being such that, in use, the passageway, said one chamber of the second cylinder zone and the other part of said one chamber of the first cylinder zone are filled with hydraulic fluid, and the application of pneumatic pressure to the other chamber of the first cylinder zone causes the primary piston to be freely displaced until it abuts the tertiary piston whereupon movement of the primary piston may be arrested or controlled.

If the control means in the passageway comprises a restricted orifice, and preferably one which is variable, to control the flow of hydraulic fluid through the passageway, the piston/cylinder unit may be arranged so that the primary piston can initially undergo rapid movement and subsequently a controlled rate of movement in one direction.

To provide a variable settable stop, the control means in the passageway may comprise a valve to close the passageway to flow when required.

If rapid movement of the primary piston is required over its full stroke in said one direction as an alternative to a controlled rate of movement over part of that stroke, then a by-pass passageway may be provided, the by-pass passageway including a valve to open and close the by-pass passageway as required.

Preferably, the said one part of said one chamber of the first cylinder zone is selectively connectable to a supply of compressed air or exhaust. Alternatively, the said one part of the one chamber of the first cylinder zone may contain a return spring.

The other chambers of the first and second cylinder zones may be air chambers, which have connections for admission and exhaustion of compressed air. It may also be appropriate to utilise such an arrangement with a single-acting unit, with spring return.

It is preferred that the primary and secondary cylinder zones be co-axial, to limit the overall length of the unit, but an end-to-end arrangement is feasible if required. The passageway, and the by-pass passageway if provided, may be incorporated in an end cap of the unit,

so that the overall length of a co-axial type of unit is very little increased, and the overall bulk is less than that of a conventional piston/cylinder unit, with an add on damping or stop mechanism.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a sectional view of one embodiment of a unit according to the invention, and

FIGS. **2** to **4** show the unit of FIG. **1** in various different states of operation.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The piston/cylinder unit shown in the drawings comprises a primary piston **11** operating in a primary cylinder zone, which it divides into chambers **12** and **13**. The primary piston **11** is attached to a piston rod **11***a* which is connected to the mechanism to be operated. A secondary piston **14** operates in a secondary cylinder zone which it divides into chambers **15** and **16**. It will be seen that the cylinder zones are co-axial, to reduce the overall length of the unit, but it is not essential that they be so.

The chamber **12** is divided into two parts **12***a* and **12***b* by a tertiary piston **33**, and the piston **33** is mounted on the piston rod **11***a* so that the piston rod **11***a* can move relative to the piston **33**.

One end cap **17** of the unit has apertures **18** and **19** for unions to provide pressure/exhaust connections for the chambers **13** and **16** respectively. The end cap **17** also has an aperture **34** for a union to provide a pressure/exhaust connection to the part **12***b* of the chamber **12**, the aperture **34** communicating with the part **12***b* of the chamber **12** through a tube **38**, a hollow interior **36** of the piston rod **11***a*, and a drilling **37** in the piston **11**. The tube **38** is secured to or is formed integrally with the end cap **17** and extends from the aperture **34** into the hollow interior **36** of the piston rod **11***a* through a seal **39**.

The other end cap **21** includes a passageway **22** interconnecting the part **12***a* of the chamber **12** and the chamber **15**. A flow control valve **23**, shown as a manually operated needle valve, is provided in the passageway **22** to provide a variable restriction to the flow of hydraulic fluid through the passageway **22**. A shut off valve **25**, also shown as a manually operated needle valve, is also provided in the passageway **22** to block the passageway **22** completely.

The end cap **21** also includes a by-pass passageway **26** to by-pass the restriction provided by the valve **23**. The by-pass passageway **26** is closable by a further shut off valve **28**, which is also shown as a manually operated needle valve.

The valves **23**, **25** and **28** need not be manually operated, but could be mechanically, pneumatically, hydraulically or electrically operated.

The part **12***a* of the chamber **12**, the passageway **22**, and the chamber **15** are filled with hydraulic fluid.

In operation, with the primary piston **11** at the right hand end of the chamber **13** and the secondary and tertiary pistons **14** and **33** in the positions shown in FIG. **2**, and with the valve **25** open and the valve **28** closed, compressed air is admitted into the chamber **13** through the aperture **18**, and apertures **19** and **34** are connected to exhaust. The piston **11** and its associated piston rod

11*a* move rapidly to the left. When the piston **11** abuts the piston **33**, hydraulic fluid is displaced through the passageway **22** and past the valve **23** and into the chamber **15** to displace the piston **14** to the right as far as it will go or until valve **25** is closed. Thus, it will be seen that the variable restriction provided by the valve **23** controls the flow of hydraulic fluid, and hence the rate of displacement of the piston **11** and the piston rod **11***a* after the piston **11** abuts the piston **33**. The piston rod **11***a* therefore advances rapidly at first and then at a controlled rate. The reverse operation is obtained by applying pneumatic pressure at aperture **19**, while connecting apertures **18** and **34** to exhaust. Piston **14** is moved to the left towards a position shown in Figure displacing hydraulic fluid through the passageway **22** past the valve **23**. The hydraulic fluid in turn displaces the piston **33** which in turn displaces the piston **11** and the piston rod **11***a* back towards the positions shown in FIG. **1**, at a rate controlled by the restriction provided by the valve **23**. Movement of the piston **33** may be arrested at, for example, the position shown in FIG. **3**, or at any other position, by closure of the valve **25**. The primary piston **11** may then be returned to its starting position by applying pressure to the connection **34** and connecting aperture **18** to exhaust.

If no initial rapid advance of the piston **11** is required, the tertiary piston **33** is moved fully to the right (as shown in FIG. **4**) and the part **12***b* of the chamber **12** is kept collapsed by connection to exhaust, so that the pistons **11** and **33** operate in unison.

If rapid advance of the piston **11** throughout its entire stroke is required, then the valve **28** is opened to open the by-pass passageway **26**.

If a hydraulic stop is required, valves **25** and **28** are both closed so that when the primary piston **11** abuts the tertiary piston **33**, movement of the primary piston **11** will be arrested. If the piston/cylinder unit is used in this mode of operation, the position of the tertiary piston **33** can be varied with one or other of valves **25** and **28** open, by applying pneumatic pressure at aperture **34** with aperture **19** connected to exhaust, or by applying pneumatic pressure at aperture **19** with aperture **34** connected to exhaust.

The piston/cylinder unit described above is extremely versatile and, as will be appreciated, can be operated in various different modes.

Various modifications may be made within the scope of the invention. For example, instead of applying pneumatic pressure to obtain reverse movement, the units may be single acting, with return springs incorporated, either in the unit itself, or in the mechanism to be operated.

What I claim is:

1. A pneumatic piston/cylinder unit comprising primary and secondary pistons operable in first and second cylinder zones respectively, and each dividing its respective cylinder zone into two chambers, one of the chambers of the first cylinder zone being connected to one of the chambers of the second cylinder zone by a passageway which includes means for controlling the flow of hydraulic fluid therethrough, and a tertiary piston in said one chamber of the first cylinder zone and dividing said one chamber into two parts, one of which is between the primary and tertiary pistons, the arrangement being such that, in use, the passageway, said one chamber of the second cylinder zone and the other part of said one chamber of the first cylinder zone are filled with hydraulic fluid, and the application of pneumatic pressure to the other chamber of the first cylinder zone causes the primary piston to be freely displaced until it abuts the tertiary piston whereupon movement of the primary piston may be arrested or controlled.

2. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein the control means in the passageway comprises a restricted orifice to control the rate of movement of the primary piston after it abuts the tertiary piston.

3. A pneumatic piston/cylinder unit as claimed in claim **2**, wherein the restricted orifice is a variable restricted orifice.

4. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein the control means in the passageway comprises a valve to close the passageway to flow so as to arrest the primary piston when it abuts the tertiary piston.

5. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein a by-pass passageway is provided between said one chamber of the first cylinder zone and said one chamber of the second cylinder zone, the by-pass passageway including a valve to open and close the by-pass passageway as required.

6. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein the said one part of said one chamber of the first cylinder zone is selectively connectable to a supply of compressed air or exhaust.

7. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein the other chambers of the first and second cylinder zones are air chambers and have connections for admission and exhaustion of compressed air.

8. A pneumatic piston/cylinder unit as claimed in claim **1**, wherein the first and second cylinder zones are co-axial.

9. A pneumatic piston/cylinder unit as claimed in claim **8**, wherein the passageway, and the by-pass passageway if provided, are incorporated in an end cap of the unit.

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